

REMARKS

Claims 2, 3, 14, 20 and 37-40 are pending, and claims 15-19 and 21-25 are withdrawn as being directed to a non-elected species but remain in the application in the event that they can be re-joined. Applicants submit arguments for overcoming the rejections based on the prior art of record and respectfully submit that the present application is in condition for allowance.

Claim Rejections - 35 USC §103(a)

- A. *In the FINAL Office Action dated March 24, 2009, claims 2, 3, 14, 20, 37 and 38 are rejected under 35 USC §103(a) as being obvious over the publication of Fan et al. titled "Deformation behavior of Zr-based bulk nanocrystalline amorphous alloys" in view of U.S. Patent No. 6,096,640 of Hu.*

The Rejection

The above rejection relies almost entirely on the disclosure provided by the Fan et al. publication for rejecting the above referenced claims, such as independent claims 2 and 37. The Examiner readily admits that Fan et al. fails to disclose a sputtering target or anything related to the field of sputtering technology, fails to disclose anything with respect to the claimed density of the claimed sputtering target, and fails to disclose a metallic glass sputtering target obtained by sintering gas atomized powder.

With respect to Fan et al. failing to disclose a metallic glass sputtering target, the Examiner states that the secondary reference, Hu, discloses a sputtering target made of an amorphous material and that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the bulk metallic glass produced in the process of Fan et al. into a sputtering target as disclosed by Hu".

With respect to Fan et al. failing to disclose the claimed density, the Examiner states that “the alloy of Fan et al. is made by casting the melt of the mixture of pure metals into a copper mould in vacuum” and that “it would have been obvious to one of ordinary skill in the art that the density of the alloy of Fan et al. would be very close to the theoretical density of the alloy, which would meet the claimed density limitation.”

With respect to Fan et al. failing to disclose a metallic glass sputtering target “obtained by sintering a gas atomized powder”, the Examiner states that this is a process limitation in a product claim and that “determination of patentability is based on the product itself.”

Patentability Arguments

(i) Metallic Glass Sputtering Target “Made of Sintered Gas Atomized Powder”

As stated above, the Examiner views the limitation “obtained by sintering a gas atomized powder” as a process limitation and gives this limitation no significance. Independent claims 2 and 37 have been amended to require a sputtering target “made of sintered gas atomized powder”. No new matter was added. Applicants respectfully submit that this is a structural limitation of the claimed sputtering target and must be given significance.

In the FINAL Office Action, the Examiner states that “the method of sintering atomized powders as claimed in the instant claims 2 and 37 is well-known in the art of powder metallurgy.” Applicants respectfully submit that this is incorrect when taking into account the material being processed. The Examiner cites no reference that discloses forming a metallic glass sputtering target as claimed by instant claims 2 and 37 of the present application by sintering gas atomized powder and provides no basis for this statement relative to one of ordinary skill in the art at the time of the invention.

As discussed in Applicants' last filed Response, metallic glass is an alloy that is able to become amorphous at cooling rates much slower than those of other known amorphous alloys. For this reason, conventional practice for producing metallic glass directs one of skill in the art to melting and casting techniques.

Research and development efforts at the time of the present invention were directed to discovering metallic glass alloys that were able to become amorphous via melting and quenching techniques at the slowest possible cooling rate. At the time of the invention, no one of ordinary skill in the art considered any different method of making a metallic glass alloy, and certainly, no one was considering a different method in which cooling rate was fast.

The present inventors discovered that there are several problems with a bulk metallic glass produced by conventional melting and casting techniques when the bulk metallic glass is to be used as a sputtering target for forming thin films via sputtering deposition for nanotechnology applications. Since the elements constituting the metallic glass forms a three-component system or greater, a sufficient amorphous state is not realized upon solidification and an uneven phase of composition is generated in the crystallized structure when the bulk metallic glass is made to a size required for a sputtering target.

As best explained on page 1, lines 18-25, of the present application, the present inventors sought a metallic glass sputtering target for forming complex-shaped films for use in the field of nanotechnology, where even a grain boundary of a formed film provides a problem in nanoprocessing. Thus, a metallic glass sputtering target that was sought by the present inventors was one that enables the formation of a film without a grain boundary. Accordingly, a sputtering target of requisite size is required to have a crystal structure that is extremely fine and uniform

(i.e. of a nano-size ultrafine, uniform structure) if it is to be capable of use in forming films in the field of nanotechnology.

However, when preparing a bulk metallic glass via prior art melting and casting techniques, it was discovered by the present inventors that it is extremely difficult to control the cooling rate of the molten metallic glass raw material, and there are cases where the cooling rate becomes faster than a critical cooling rate. In particular, when preparing a large size bulk body (of a size required for a sputtering target), a cooling speed gradient will occur in the bulk body, and a part of the bulk will be crystallized easily. As a result, a part of such bulk body will crystallize, and unevenness will arise in the composition of the bulk metallic glass rendering it completely unusable as a sputtering target for use in forming thin films in the field of nanotechnology.

This is because, when a metallic glass having the above referenced kind of uneven composition is sputtered, deterioration in sputtering characteristics such as the generation of nodules and arcing will occur as a matter of course, the there will be an adverse effect on the uniformity of the film. Such a body could clearly not be used as a sputtering target for forming films used in the field of nanotechnology. However, at the time of the invention, the melting and casting technique was the only conventional manufacturing method used for forming metallic glass. See: (i) the sentence bridging columns 1 and 2 on page R3761 of the Fan et al. publication; (ii) page 1, line 30, to page 2, line 15, of the present application, as filed; and (iii) page 678, the first three sentences of Section Two, and page 670-680, all of Section Four and FIG. 2, of the cited Kakiuchi et al. "Golf Club" publication.

Accordingly, the present invention was devised in order to overcome the foregoing drawbacks in the production of a bulk metallic glass via melting and casting as described above.

The present invention produces a metallic glass sputtering target by an entirely different technique. To this end, the present inventors prepared raw material powder via a gas atomization method and then sintered the obtained powder. This was entirely different to conventional manufacturing methods for bulk metallic glass at the time of the invention.

At the time of the invention, it was difficult to consider by the present inventors that a metallic glass sputtering target produced with powder metallurgy would be able to obtain a sputtering target of the same quality, much less one of improved quality, as the bulk metallic glass produced via melting and casting; rather, it was natural to consider this to be impossible. The results were entirely unexpected. Nevertheless, with the present invention, it became possible to produce a sputtering target that is, not only as good a quality, but of a superior quality to the bulk metallic glass produced via melting and casting. The quality was so good, that it enabled complex-shaped films to be deposited and used in the field of nanotechnology where even a film with a grain boundary is unacceptable.

As described in detail in the specification of the present application, as filed, upon sintering the raw material powder via a gas atomization method, the cooling rate gradient in the powder is extremely small, and, even if crystallization occurred, there is a significant advantage in that the unevenness of the composition will be extremely small. This is in direct contrast to melting and casting techniques in which the cooling rate gradient is great when casting a body the size required of a sputtering target.

Further, with the present invention, it is possible to minimize the influence on process changes that often occur in commercial manufacturing processes, and a metallic glass having a uniform composition can be prepared stably and repeatedly.

Accordingly, the present invention provides a method that is significantly superior to the prior art melting and casting method and produces sputtering targets of a quality not capable of being produced by prior art melting and casting methods. Moreover, this is a sputtering target formed from a new (higher quality) metallic glass, and the present invention provides a novel manufacturing method of such a higher quality metallic glass target.

For these reasons, Applicants respectfully submit that the above referenced rejection has been overcome and should be removed. Fan et al. clearly fails to disclose a metallic glass sputtering target “made of sintered gas atomized powder”. Also, for the reasons stated above, it would not have been obvious for one of ordinary skill in the art at the time of the invention to provide a metallic glass sputtering target “made of sintered gas atomized powder”. Applicants respectfully request reconsideration and removal of the rejection.

(ii) Metallic Glass Sputtering Target “Having an Ultrafine Crystal Structure”

Claims 2 and 37 of the present application have been amended to require the metallic glass sputtering target to have “an ultrafine crystal structure with an average crystallite size of 1nm to 5nm”. Claims 2 and 37 also require this crystal structure to be uniform throughout the metallic glass sputtering target. Further, the limitation with respect to the sputtering target being an “amorphous material” has been deleted. No new matter was added; for example, see the present application, as filed, on: page 1, lines 7-8; page 2, lines 19-20; page 5, lines 4-6 and 12; page 8, lines 15-16; and on page 13, Table 1, the column labeled “Average Crystallite Size (nm)”.

In the FINAL Office Action, it is stated that “it is noted that the material as claimed in instant claims 2 and 37 is an amorphous material rather than a crystalline material”. Claims 2 and 37 have been amended to remove this limitation as discussed above.

In addition, in the Office Action it is stated that the Fan et al. publication is interpreted as disclosing “a Zr-based bulk nanocrystalline amorphous alloy $Zr_{53}Ti_5Ni_{10}Cu_{20}Al_{12}$ having an average grain size of 2.0nm to 2.5nm being uniform entirely throughout the specimen” (of course, the specimen of Fan et al. is of a miniature size (2mm in diameter) significantly smaller than that required for the diameter (100mm or greater) of the sputtering target recited in claims 2 and 37 of the present application). Nonetheless, the Examiner concludes that “the alloy structure of Fan et al. is substantially identical to that of the claimed structure” of the metallic glass sputtering target of the present application. Applicants respectfully disagree and submit that this is an error.

The Fan et al. publication discloses that the alloy structure of the miniature specimen is of a pure amorphous state in the quenched state. In an annealed state, the Fan et al. publication discloses that the alloy structure of the miniature specimen is of a state where “many fine crystals (arrows in FIG. 2) are dispersed in the amorphous matrix” (see page R3762, right column, lines 5-7 of Fan et al.) or is of a state where “nanocrystals ... were embedded in the amorphous matrix” (see the Abstract of Fan et al.). Further see: page R3762, left column, line 28, to right column, line 18; Fig. 2; and the Abstract of the Fan et al. publication.

In contrast, claims 2 and 37, as amended, require metallic glass sputtering targets “having a diameter of 100mm or more and an ultrafine crystal structure with an average crystallite size of 1nm to 5nm, said average crystallite size of 1nm to 5nm being uniform entirely throughout said sputtering target”. Such a metallic glass sputtering target structure is not the same as the

specimen made of a pure amorphous material disclosed by Fan et al. (in the quenched state) nor is it the same as a specimen made of an amorphous base material with fine crystals dispersed therein as illustrated in FIG. 2 of the Fan et al. publication (in an annealed state). Accordingly, there is a clear structural difference in an alloy structure in a state where fine crystals are dispersed in an amorphous material as in the disclosed specimen of Fan et al. and in a state where the entire structure is formed of fine crystals as required by independent claims 2 and 37 of the present application.

For these reasons, Applicants respectfully submit that the above referenced rejection has been overcome and should be removed. Fan et al. clearly fails to disclose a metallic glass sputtering target wherein the entire structure is formed of fine crystals and not merely made of an amorphous base material in which fine crystals are dispersed. Applicants respectfully request reconsideration and removal of the rejection for at least this reason.

(iii) Metallic Glass Target “Having a Relative Density of at least 96.4%”

Independent claims 2 and 37 of the present application require a metallic glass sputtering target “having a relative density of at least 96.4%”.

In the FINAL Office Action, the Examiner concludes that since the specimen of Fan et al. is made by casting, the alloy density will be extremely close to theoretical density. Thus, it is stated that it would be obvious to satisfy the limitation of density required by the claims of the present application. Applicants respectfully disagree and believe this to be an error.

When one of ordinary skill in the art employs molten metal casting as taught by Fan et al., defects from ingot piping and microporosity will arise and will prevent the cast ingot from achieving density anywhere close to theoretical density. As acknowledged by the Examiner, Fan

et al. do not in any way refer to density, and certainly, do not provide any teachings with respect to overcoming the above referenced extremely-challenging practical problems with approaching anywhere close to theoretical density for a metallic glass material. Accordingly, Applicants respectfully submit that it is an error to conclude that it would be obvious to one of skill in the art to produce a cast ingot according to the teachings of Fan et al. that could closely approach theoretical density and be of the level required by the claims of the present application.

For this reason, Applicants respectfully submit that the above referenced rejection has been overcome and should be removed. Fan et al. clearly fails to disclose a metallic glass sputtering target of the claimed density, and achieving close to theoretical density for such a material would certainly not be obvious to one of ordinary skill in the art. Applicants respectfully request reconsideration and removal of the rejection for at least this reason.

(iv) One of Skill in the Art would not Combine Fan et al. with Hu

Hu describes a high melting point metal silicide that is completely different from the metallic glass of the Fan et al. publication.

In the FINAL Office Action, it is stated that Hu is “only relied upon for meeting the claimed limitation of making an amorphous material into a sputtering target” and that the amorphous material for the sputtering target as disclosed by Hu does not have to be the same as the claimed metallic glass.” Applicants respectfully submit that this is an error.

In KSR Int'l v. Teleflex Inc., 127 S.Ct. 1727, 82 USPQ2d 1385 (2007), the U.S. Supreme Court clearly states that an Examiner must provide a sufficient reason or explicit analysis of why the disclosures of references should be combined and that rejections on obviousness grounds cannot be sustained by mere conclusory statements.

With respect to the present matter, Applicants respectfully submit that one of ordinary skill in the art relying on common sense at the time of the invention would not have reasonably looked to the teaching of a high-melting point metal silicide taught by Hu relative to the teaching of a miniature specimen of a metallic glass alloy of the Fan et al. publication. A high-melting point metal silicide is a completely different material than that of a metallic glass and the physical properties and usage of these different materials are entirely different. There is simply no common sense reason why one of skill in the art would reasonably expect that applying a teaching with respect to a high-melting point metal silicide to a metallic glass alloy would achieve the same results.

Accordingly, although the material of Hu may not have to be “the same” as the metallic glass of Fan et al. for it to be obvious for one of ordinary skill in the art to combine the teachings, there must be some common sense relation, similarity, or expectation of success for the combination to be considered obvious. There is simply no relation or common sense thread that would cause one of ordinary skill in the art to consider combining these references for any reason. Thus, Applicants respectfully submit that the modification of the technology taught by Fan et al. with the extremely different and unrelated technology taught by Hu would not have been obvious to one of ordinary skill in the art at the time of the invention. The only basis for such a combination is clearly via a hindsight analysis, which the U.S. Supreme Court has said to be improper.

For this reason, Applicants respectfully submit that the above referenced rejection has been overcome and should be removed. Here, where common sense dictates that it would not be obvious for one of skill in the art to randomly combine the teachings of Fan et al. with Hu, Applicants respectfully request reconsideration and removal of the rejection.

B. In the FINAL Office Action dated March 24, 2009, claims 39 and 40 are rejected under 35 USC §103(a) as being obvious over the publication of Fan et al. titled "Deformation behavior of Zr-based bulk nanocrystalline amorphous alloys" in view of U.S. Patent No. 6,096,640 of Hu and further view of the publication of Kakiuchi et al. titled "Application of Zr-Based Bulk Glassy Alloys to Golf Clubs".

Applicants respectfully submit that dependent claims 39 and 40 are patentable over Fan et al. in view of Hu and further in view of Kakiuchi et al. for the same reasons discussed above that independent claims 2 and 37 are patentable over Fan et al. in view of Hu.

Accordingly, Applicants respectfully request reconsideration and removal of the rejection of claims 39 and 40.

Conclusion

In view of the above amendments and arguments, Applicants respectfully submit that the rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

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